CONCENTRATION OF GREENHOUSE GAS EMISSIONS IN THE EUROPEAN UNION

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Abstract

First part of the article reviews theoretical foundations of state intervention in GHG emissions. The second part estimates the level of such emissions in EU countries based on the European Environment Agency's data using Lorenz curve and Gini coefficient. Since 1990 GHG emissions dropped by 40% in the metals industry. It is observed that four biggest GHG emitters in the metals industry: Germany, Poland, Austria and the Czech Republic are responsible for half of all GHG emissions.

Keywords: greenhouse gas emission, metallurgy

1. INTRODUCTION

Over the last several decades, CO2 levels in the atmosphere have undoubtedly increased. In accordance with studies conducted since the pre-industrial period, up until now the CO2 level increased from 280 ppm to almost 400 ppm, [1] which is the highest since at least 800,000 years [2]. Although there are divergent opinions on the origins of climate changes or their effects, most scientists agree that this process is caused by human activities. The last Intergovernmental Panel on Climate Change (IPCC) report clearly states that - with 95% certainty - human activity is responsible for at least half of warming observed between 1951 and 2010 due to GHG emissions. Furthermore, it is expected that the average temperature growth between 2006 and 2015, in comparison to the average from 1986-2005, will be between 0.3 and 0.7 degrees depending on the scenario, which will cause far-reaching consequences for the natural environment [3]. Seeing the necessity of state action, countries led by UN concluded the United Nations Framework Convention on Climate Change in 1992. Its most important binding instrument is the Kyoto Protocol signed in 1997. On its basis, developed countries and countries in the process of political transition agreed to reduce GHG emissions by at least 5% in comparison to 1990. The European Union, in order to satisfy these requirements, has implemented the CO2 Emission Trading System (ETS). It has covered more than 10,000 facilities across 27 EU member states: oil refineries, power plants of over 20 MW, coke ovens, iron and steel plants, along with cement glass lime brick, pulp and paper installations [4].

2. METHODS

The purpose of this study is to assess the amount of GHG emissions from metals industry in comparison to all GHG emissions and to study concentration of emissions in the EU countries.

The studies used European Environment Agency data regarding CO2 emissions in the European Union countries. In the CSE database, sub-category Iron and steel production (2.C.1) includes sinter production, pig-iron production, oxygen steel production, electric steel production, hot and cold rolling and iron and steel castings. Production of ferroalloys (2.C.2) is listed directly as such in the CSE. Aluminum production (2.C.3) is sub-divided into primary aluminum and remelted aluminum. Sub-category Other (2.C.5) includes lead production, thermal galvanization, copper production and zinc production.

Gini coefficient was used to assess the GHG emission concentration level. It is strictly linked with the Lorenz curve (hence its second name - "Lorenz concentration ratio"). Since it is the most commonly used inequality measure, it contains many formal representations. One of such representations is described below [5]:

$$G = \frac{1}{2\mu n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| x_i - x_j \right| \tag{1}$$

μ - average emission

n - sample size

Gini coefficient of 0 expresses egalitarian distribution, while a Gini coefficient of 1 expresses maximal inequality. This equation may be interpreted as half of the absolute emission difference between all countries in relation to average emission. This coefficient satisfies the Pigou-Dalton Principle of Transfers (it changes by transferring emissions from high-income countries to lower-income countries) and principles of symmetry, homogeneity, replication. It does not, however, satisfy the decomposition principle.

Lorenz curve illustrates accumulated percentage of GHG emissions for subsequent countries in order from lowest to highest emission. In a theoretical case, when emissions of all countries are equal, the Lorenz curve becomes a straight line at 45 degrees (curve of absolute equality). However, such situation does not actually occur. The greater the emission diversity, the more the actual curve differs from the curve of absolute equality. The Gini coefficient is a quantitative measurement of this inequality, which equals 2 x the field between the actual curve and the curve of absolute equality. It may take values from 0 - absolute equality of income - to 1 - all income is accumulated in hands of one person.

3. RESEARCH RESULTS

3.1 CO2 emission as externalities and theoretical basis for state intervention

The EU's Emission Trading System is based on a theoretical principle of welfare economics and its issue of market failure. Externalities are one of such basic failures. They occur in a situation where one entity's actions influence other persons' situations. Such influence may generate costs for such persons - it is then called negative externalities - or benefits (positive externalities). This concept is related to complete markets, necessary for the existence of Pareto optimality, which is the existence of markets for all goods and services. The existence of externalities means that this completeness does not exist to a certain extent, since such benefits or costs are imposed outside the market [6]. It causes sub-optimal allocation of resources (in the sense of Pareto), because one of conditions for optimality is broken - equality of marginal rates of transformation and substitution. Due to negative externalities, entities causing them do not pay all costs of their actions, which increases the scale of their activities over the limit. The opposite occurs when, despite the existence of positive externalities, entities do not receive appropriate benefits for their activities and thus will not undertake them frequently enough. It raises the question whether the state should intervene in such situations. Coase says that it should not, because each party, injured or benefiting from them, may negotiate removal of such externalities in order to create a socially desired effect [7]. In the current economic situation, externalities resulting from the companies influencing the natural environment have the biggest impact. Because negotiating between entities polluting the environment and the rest of society is difficult due to organizational and technical reasons, it seems that Coase's approach is not very accurate and the existence of such externalities is a reason for state intervention. The society as a whole is interested in increasing the amount of activities with positive externalities and decreasing negative externalities, therefore the role of state is to provide appropriate framework for such actions.

3.2 Greenhouse gases emission in the EU

Based on this definition of externalities, the EU has decided that using market-based mechanisms should be the best method of decreasing CO2 emissions. If a company has excess emission rights, it can sell them, if it doesn't have enough rights, it has to purchase them. Thanks to the “invisible hand of the market”, a proper price for emission rights will set itself and result in decreased CO2 emissions without introducing separate taxes [8]. Actions undertaken by companies faced with additional costs for emission rights, such as introducing biomass as an energy source for producing metals, will lead to the above [9].

I order to meet the requirements of the Kyoto Protocol, the EU has introduced the Emission Trading System (ETS). However, it has to be pointed out that EU constantly reduces GHG emissions since 1990. In 1990 it amounted to 5574.4 millions of tonnes, while in 2011 it was reduced to 4550.21 millions of tonnes. Former Eastern Bloc countries had a huge impact on this process and - after their political transformations - completely remodeled their industries, removing ineffective installations, which were the highest contributor of CO2 emissions. Germany is currently the biggest emitter of greenhouses gases in the EU, emitting 916.5 millions of tonnes of greenhouse gases (see **Fig. 1**). However, it is necessary to point out that this country has reduced their GHG emissions by 26% since 1990.

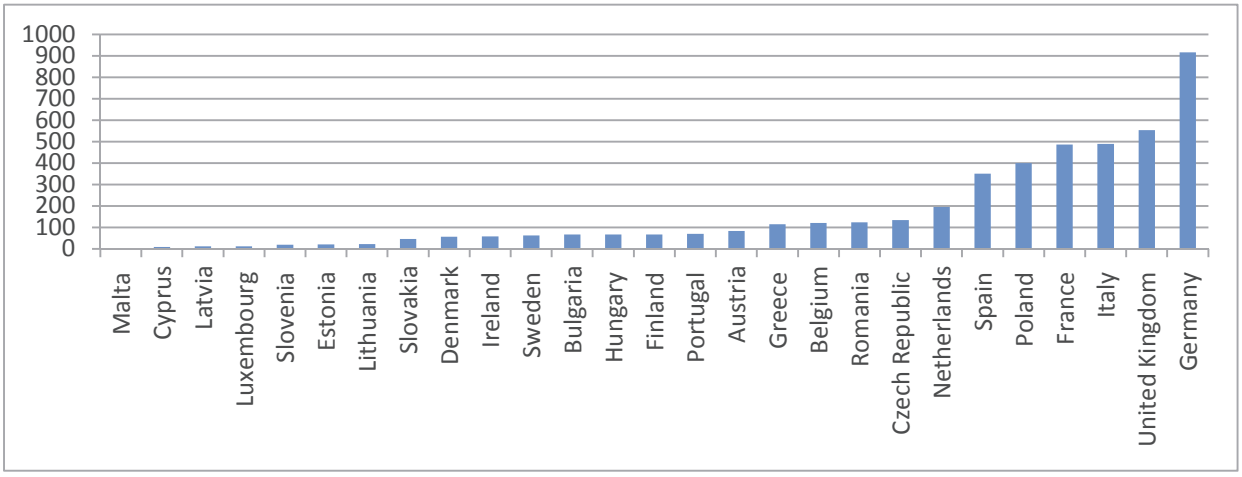

Fig. 1 GHG emission (CO2 equivalent) in the EU in 2011 (millions of tonnes)
Source: Own analyses based on European Environment Agency Data

Great Britain, Italy, France, Poland and Spain are the next biggest GHG emitters that emit considerably less greenhouse gases. Among them only Spain increased GHG emissions from 282.8 millions of tonnes in 1990 to 350.5 millions of tonnes in 2011.

3.3 Metals industry’s greenhouse gases emission in the EU

The European Commission noted that this industry is inseparably connected with high energy use as well as ecological costs and the risk of moving its production to countries with less stringent GHG emission limits [10]. In 1990 the metals industry’s GHG emission was 106 millions of tonnes. By 2011 it was reduced by 40% to 63.9 millions of tonnes. The process of changing the contribution of GHG emissions of the metals industry to global emissions amount is charted below. **Fig. 2** sets this contribution on a low level of 1.4% in 2011.

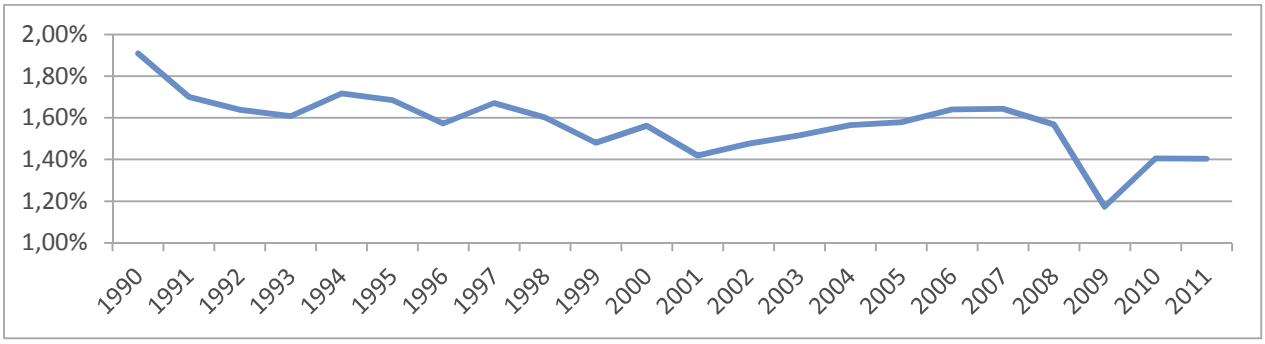

Fig. 2 The metals industry's contribution in total EU CO2 emission between 2000 and 2011
Source: Own analyses based on European Environment Agency data

This contribution decreased from 1.91% in 2001 to 1.4% in 2011 throughout the whole period. A particularly large drop was noted in 2009. It can be assumed that global economic situation in the EU was the deciding factor. Financial crisis begun in 2008 and influenced actual economies in the following year, reducing production rates and thus GHG emissions. The biggest emission level of the metals industry was noted in 1990, when it emitted 106 millions of tonnes of GHG. The metals industry's GHG emission contribution in EU countries in 2011 is shown on the **Fig. 3**.

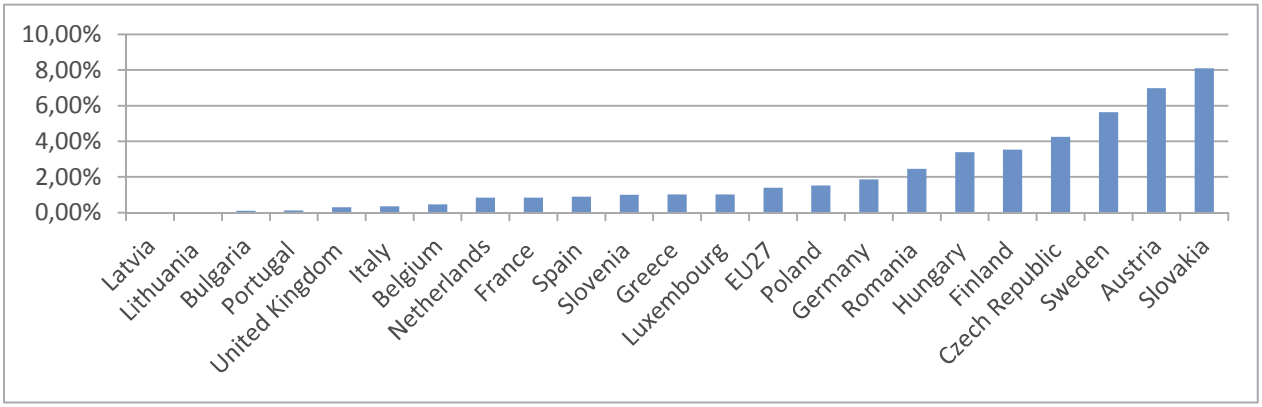

Fig. 3 The metals industry's contribution in total EU CO2 emission in 2011
Source: Own analyses based on European Environment Agency Data

The Czech Republic (4.25%), Sweden (5.63%), Austria (6.99%) and the Slovak Republic (8.09%) were the biggest contributors in the metals industry's contribution to the GHG emission. It is related to the chief branches of industry in each country, e.g. in the Slovak Republic the metals industry export is worth EUR 11 billion and accounts for 11% of this country's export.

However, the **Fig. 4** seems more interesting regarding the metals industry's GHG emission. It represents the Lorenz curve calculated on the basis of the EU countries' GHG emission in 2011.

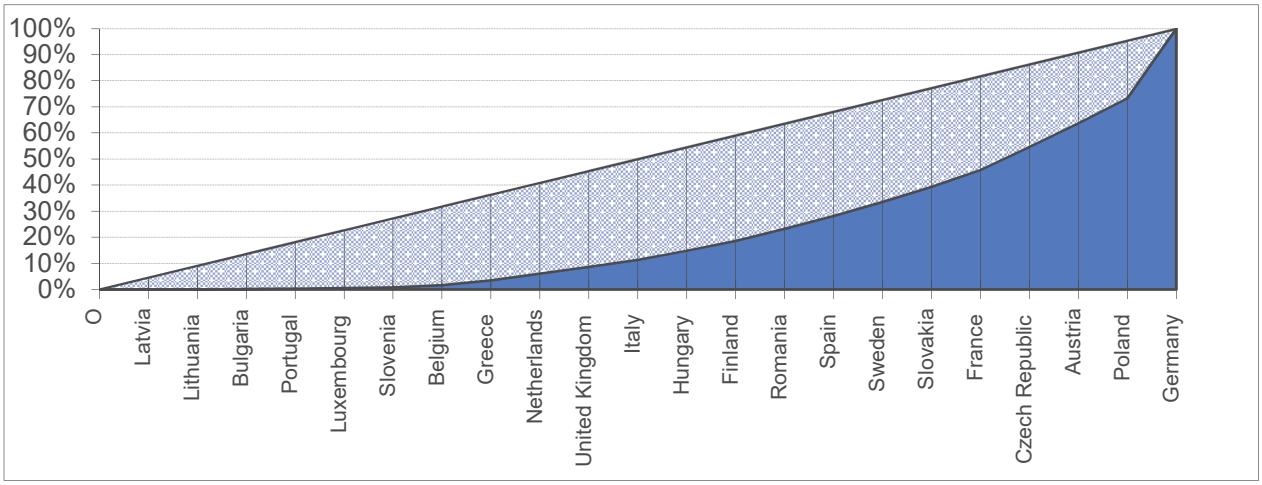

Fig. 4 CO2 emission concentration in the metals industry
Source: Own analyses based on European Environment Agency data

Based on **Fig. 4**, it can be deduced that four biggest GHG emitters in the metals industry: Germany, Poland, Austria and the Czech Republic are responsible for half of all GHG emissions in the EU's metals industry. Furthermore, the Gini coefficient calculated on the basis of the Lorenz curve for 2000-2011 indicates rising concentration of GHG emissions in these countries (see **Fig. 5**).

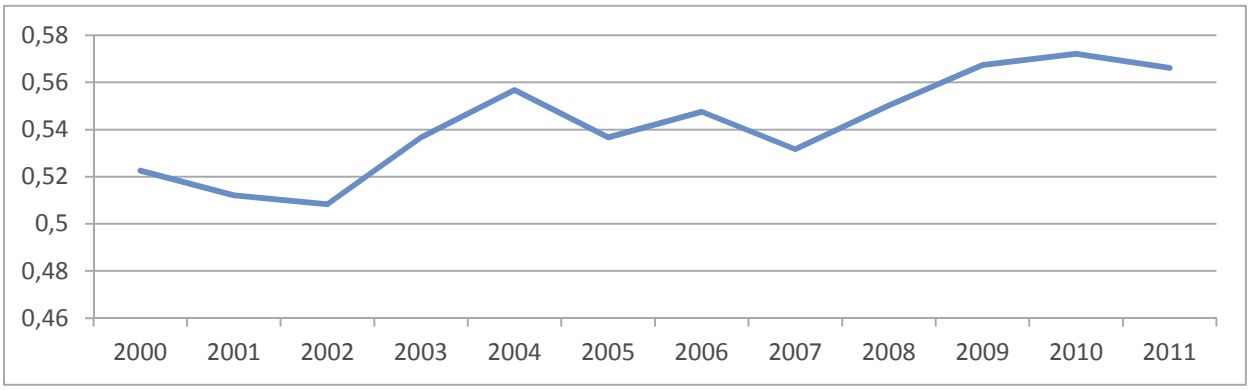

Fig. 5 Value of the Gini coefficient for the metals industry's CO2 emission between 2000 and 2011 in the EU
Source: Own analyses based on European Environment Agency data

We can observe an upward trend for the Gini coefficient since 2000. It means that the diversification of GHG emissions in the EU is rising, which suggests that the biggest emitters are increasing their emission, while other countries are decreasing it.

CONCLUSION

Conducted studies allow us to draw the following conclusions:

1. Since 1990 the EU has decreased CO2 emissions dramatically both for total emission level as well as the metals industry's contribution.
2. The metals industry's contribution in total EU GHG emission systematically decreases since the beginning of 1990 and is currently at 1.4%. However, there are countries, which significantly surpass the EU average: The Czech Republic (4.25%), Sweden (5.63%), Austria (6.99%) and the Slovak Republic (8.09%).

3. Gini coefficient calculated for the metals industry's GHG emission in 2011 was 0.57. It is a high level, which signifies a high concentration of GHG emissions in a few countries. This coefficient is slightly rising, which signifies progressing concentration of GHG emissions.

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